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THE RELATIONSHIP BETWEEN TEACHERS' YEARS-OF-TEACHING EXPERIENCE AND STUDENTS' MATHEMATICS ACHIEVEMENT

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by

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Abstract

This study examined differences in student achievement on the 2000 National Assessment of Educational Progress (NAEP) Mathematics Test by their teachers' years-of-experience teaching mathematics. Data examined were mean scale scores of fourth and eighth grades in five sample groups: national (public and private school students combined), national public school students, and Kentucky, Tennessee and Texas public school students. These states were chosen because of their statewide systematic school reform efforts. The research question was: Are mathematics scores of students of more experienced mathematics teachers higher than those of students of less experienced teachers? The National Assessment of Educational Progress data include "years-of-teaching mathematics experience" with five categories: 2 years or less, 3-5 years, 8-10 years, 11-24 years, and 25 years or more. The NAEP Data Tool was used to create descriptive tables of mean scale scores across categories and to test for statistically significant differences. Effect size was calculated by the researcher. Statistically significant differences ($p < .01$) in the eighth grade scores were found to be related to teaching experience in national, national public, Kentucky, and Texas samples, but not in the Tennessee sample. These results indicated that the students of teachers with more years of experience teaching mathematics had higher mathematics scores on the eighth grade 2000 NAEP Mathematics Test. However, the effect sizes were either very small or small (ranging from .08 to .39).

The Relationship Between Teachers' Years-of-Teaching Experience and Students' Mathematics Achievement

Teaching is one of the few professions in which the professionals are assumed to be able to exhibit excellence the first year on the job. Public school teaching appears to be easy. Most American adults have spent long hours—as students—observing teachers teach. Yet, there is research evidence that experience counts. This evidence comes with the concomitant implication that effective teaching strategies are learned on the job.

Research studies examining the teacher characteristic "years-of-teaching experience" are plentiful across the years of the ERIC database. Stone (1997) found that teacher leadership was positively correlated with years-of-teaching experience. Klecker and Loadman (1998,1997) found no difference by years-of-teaching experience in either teachers' ratings' of their sense of empowerment or teachers' ratings of their overall job satisfaction.

Felter (2001) found a positive relationship between teacher experience and preparation and student achievement despite the effects of student poverty. Bodenhausen (1988) found that students of teachers with more than 10 years of experience teaching advanced placement classes had higher scores on advance placement tests. Chidolue (1996) found significant positive relationships between teachers' teaching experience and student achievement in high school biology classes. Darling-Hammond (2002) summarized research on the relationship of teachers' years-of-teaching experience with student achievement.

> *Teaching Experience*. Other studies of the effects of teacher experience on student learning have found a relationship between teachers' effectiveness and their years of experience (Murnane & Phillips,

> 1981; Klitgaard & Hall, 1974), but not always a significant one or an entirely linear one. While many studies have established that inexperienced teachers (those with less than three years of experience) are typically less effective than more senior teachers, the benefits of experience appear to level off after about five years, especially in non-collegial work settings (Rosenholtz, 1986). A possible cause of this curvilinear trend in experience effects is that older teachers do not always continue to grow and learn and may grow tired in their jobs. Furthermore, the benefits of experience may interact with educational opportunities. Veteran teachers in settings that emphasize continual learning and collaboration continue to improve their performance (Rosenholtz, 1984) (Darling-Hammond, 2000, p. 6).

The purpose of this study is to continue the exploration of student achievement across teachers' years of experience. The National Assessment for Educational Progress (NAEP) Mathematics Test data provide national and state-by-state scaled scores from a randomly selected student population. The questions included in the NAEP database permitted a cross-sectional analysis by years of mathematics teaching, rather than simply years of experience in the teaching profession.

The Research Question

The research question for this study was: Are mathematics scores of students of more experienced mathematics teachers higher than those of students of less experienced teachers?

Methodology

Data collection for the National Assessment for Educational Progress Mathematics Test was described by the National Center for Educational Statistics (2002a, p. 4):

> *Description of School and Student Samples*
>
> The NAEP 2000 mathematics assessment was conducted nationally at grades 4, 8, and 12 and state-by-state at grades 4 and 8. The national assessment included representative samples of both public and nonpublic schools. The state-by-state assessments included only public schools. In the national sample approximately 14,000 fourth-graders, 16,000 eighth-graders, and 13,000 twelfth-graders were assessed. In the state assessments, approximately 100,000 students at each of grades 4 and 8 were assessed. The number of schools in the reporting sample were 742 at grade four, 744 at grade 8, and 558 at grade 12. Additional information about school and student samples is given in appendix A (pages 189-194).

Data Analysis

The NAEP Data Tool (National Center for Educational Statistics, 2002b) was used to create data tables from selected national and state results from the 2000 National Assessment of Educational Progress (NAEP) Mathematics Assessments for fourth and eighth grade students. The years-of-teaching experience categorization of the data was created by choosing the NAEP question," Counting this year, how many years in total have you taught mathematics? (Include any permanent, full-time, or part-time assignments, but not substitute assignments.) (teacher-

reported)" (National Center for Educational Statistics, 2002). Thus, "years-of-teaching experience" is defined for this study as years of experience teaching mathematics.

Statistical significance. Alpha level of .01 was used for all statistical tests. The NAEP Data Tool for "testing for statistically significant differences" was used to test observed mean scale score differences. This section of the NAEP Data Tool yielded (1) statistically significant differences between groups, (2) the mathematical difference between the means, and (3) the calculated and *p*-value—reported to four decimal places. Statistical significance is reported in this paper at $p < .01$.

Effect size. Effect size was calculated by dividing the difference between the two mean scale scores by the average of the standard deviation of the two categorical groups and is interpreted as follows: an effect size of .2 is small, .5 is medium, and .8 is large (Cohen, 1988). The standard deviation for each group was calculated by (1) multiplying N by the row percent of the category to find n of the category; (2) taking the square root of n; (3) multiplying the square root of n times the standard error (provided).

Results

Table 1 below summarizes the NAEP performance results for Grade 4 and Grade 8 in the national (public and private combined), national public, Kentucky public, Tennessee public, and Texas public samples. The remaining Tables present the comparisons made of mathematics achievement and years-of-teaching experience in each of the sample categories.

Table 1. Overall Average Student Scale Scores on the 2000 Mathematics National Assessment of Educational Progress.

NAEP Assessment	N	Average Scale Score	Standard Error
National fourth grade	13,511	288	0.9
National eighth grade	15,694	275	0.8
National Public Schools fourth grade	7,070	226	1.0
National Public Schools eighth grade	9,353	274	0.8
Kentucky fourth grade	2,275	221	1.2
Kentucky eighth grade	2,294	272	1.4
Tennessee fourth grade	2,488	220	1.5
Tennessee eighth grade	2,232	263	1.7
Texas fourth grade	2,171	233	1.2
Texas eighth grade	2,317	275	1.5

Table 2 reveals that average student scale scores of the national grade 4 NAEP mathematics assessment ranged from 223 to 230 across the years-of-teaching experience categories. More than half the teachers (54%) had 11 or more years of teaching experience. There were no statistically significant differences ($p < .01$) between the mean scale scores of students with teacher in the categories of years-of-teaching experience.

Table 2. 2000 NAEP National Mathematics Grade 4 Scores by Years-of-Teaching Experience.

OVERALL PERFORMANCE															
	2 years or less			3-5 years			6-10 years			11-24 years			25 years or more		
N	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.
11,879	223	1.7	12%	224	2.2	16%	226	1.4	18%	227	1.3	33%	230	2.4	21%

Average student scale scores for the national grade 8 NAEP mathematics assessment ranged from 270 to 282 across their teachers' years-of-teaching experience categories (Table 3). The mean scale score of students with teachers in the 25 years-or-more category (282) was statistically significantly ($p < .01$) higher than the mean scale score students with teachers in the 2 years-or-less category (270) with an effect size of .10.

Table 3. 2000 NAEP National Mathematics Grade 8 Scores by Years-of-Teaching Experience.

OVERALL PERFORMANCE															
	2 years or less			3-5 years			6-10 years			11-24 years			25 years or more		
N	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.
13,288	270	2.4	18%	277	2.5	16%	276	2.0	19%	278	1.4	32%	282	2.5	15%

Additionally, the mean scale score students with teacher in the 11-24 years-of-teaching experience category (278) was statistically significantly ($p < .01$) higher than the mean scale score students with teachers in the 2 years-or-less category (270) with an effect size of .08.

Turning to Table 4, average student scale scores for the national public school grade 4 NAEP mathematics data ranged from 221 to 230 across their teachers' years-of-teaching experience categories. Approximately half the teachers (51%) had 11 or more years-of-teaching

experience. There were no statistically significant differences ($p < .01$) between student scores across the categories of years-of-teaching experience.

Table 4. National Public School Mathematics Grade 4 Scores by Years-of-Teaching Experience.

OVERALL PERFORMANCE															
	2 years or less			3-5 years			6-10 years			11-24 years			25 years or more		
N	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.
6083	221	2.1	14%	227	2.8	17%	225	1.8	18%	227	1.5	32%	230	2.8	19%

Average student scale scores for the national public school grade 8 NAEP mathematics test ranged from 269 to 282 across their teachers' years-of-teaching experience categories (Table 5). The mean scale score of students of teachers with 25 years or more of teaching experience (282) was statistically significantly ($p < .01$) higher than the mean scale score of students of teachers with 2 years or less of teaching experience (269) with an effect size of .14.

Table 5. National Public School Mathematics Grade 8 Scores by Years-of-Teaching Experience.

OVERALL PERFORMANCE															
	2 years or less			3-5 years			6-10 years			11-24 years			25 years or more		
N	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.
7935	269	2.7	17%	276	2.8	16%	275	2.2	19%	277	1.5	32%	282	2.7	15%

Additionally, the mean scale score of students with teachers with 11-24 years-of-teaching experience (277) was statistically significantly ($p < .01$) higher than the mean scale score students of teachers with 2years or less of experience (270) with an effect size of .08.

As seen in Table 6, average student scale scores for the Kentucky grade 4 NAEP mathematics tests ranged from 217 to 228 across the years-of-teaching experience categories. Half the Kentucky teachers (50%) had taught mathematics for 11 or more years. There were no statistically significant differences ($p < .01$) between the fourth grade students' NAEP mathematics scores by their teachers' years-of-teaching experience

Table 6. 2000 NAEP Kentucky Mathematics Grade 4 Scores by Years-of-Teaching Experience.

OVERALL PERFORMANCE															
	2 years or less			3-5 years			6-10 years			11-24 years			25 years or more		
N	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.
2,080	217	3.7	15%	219	2.8	22%	219	2.4	19%	223	2.0	32%	228	4.8	12%

Average student scale scores for the Kentucky grade 8 NAEP mathematics test ranged from 266 to 281 across the years-of-teaching experience categories (Table 7). The mean scale score of students of teachers with 11-24 years-of-teaching experience (279) was statistically significantly ($p < .01$) higher than the mean scale score of students of teachers with 2 years or less years of experience (266) with an effect size of .21.

Table 7. 2000 NAEP Kentucky Mathematics Grade 8 Scores by Years-of-Teaching Experience.

OVERALL PERFORMANCE															
	2 years or less			3-5 years			6-10 years			11-24 years			25 years or more		
N	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.
2066	266	4.2	15%	267	3.1	21%	270	2.7	26%	279	2.0	33%	281	5.6	5%

Furthermore, the mean scale score of Kentucky students with teachers with 11-24 years-of-teaching experience (279) was also higher than the mean scale score of students of teachers with 3-5 years-of-teaching experience (267) with an effect size of .34, and the mean scale score of students with teachers with 6-10 years-of-teaching experience (270) with an effect size of .16.

Average student scale scores for the Tennessee fourth grade NAEP mathematics tests ranged from 214 to 223 across the years-of-teaching experience categories (Table 8). Approximately half the Tennessee teachers (53%) had taught mathematics for 11 or more years. There were no statistically significant differences ($p < .01$) between the Tennessee fourth grade students' NAEP mathematics scores by their teachers' years-of-teaching experience.

Table 8. 2000 NAEP Tennessee Mathematics Grade 4 Scores by Years-of-Teaching Experience.

OVERALL PERFORMANCE															
	2 years or less			3-5 years			6-10 years			11-24 years			25 years or more		
N	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.
2397	214	3.9	14%	219	4.3	14%	223	3.3	19%	221	1.9	38%	221	3.2	15%

In Table 9 below, average student scale scores for the Tennessee eighth grade NAEP mathematics tests ranged from 254 to 271 across their teachers' years-of-teaching experience categories. Approximately half the Tennessee teachers (49%) had taught mathematics for 11 or more years. There were no statistically significant differences ($p < .01$) between the Tennessee eighth grade students' NAEP mathematics scores by their teachers' years-of-teaching experience in mathematics.

Table 9. 2000 NAEP Tennessee Mathematics Grade 8 Scores by Years-of-Teaching Experience.

OVERALL PERFORMANCE															
	2 years or less			3-5 years			6-10 years			11-24 years			25 years or more		
N	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.
2076	254	5.2	15%	258	4.0	16%	264	2.6	20%	271	3.2	31%	268	7.2	18%

Table 10 shows that average student scale scores for the Texas fourth grade NAEP mathematics tests ranged from 233 to 237 across their teachers' years-of-teaching experience categories. Almost half the Texas teachers (48%) had taught mathematics for 11 or more years. There were no statistically significant differences ($p < .01$) between the Texas fourth grade students' NAEP mathematics scores by their teachers' years-of-teaching experience.

Table 10. 2000 NAEP Texas Mathematics Grade 4 Scores by Years-of-Teaching Experience.

OVERALL PERFORMANCE															
	2 years or less			3-5 years			6-10 years			11-24 years			25 years or more		
N	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.
1976	233	2.4	15%	230	2.3	17%	232	2.1	20%	236	1.6	34%	237	3.2	14%

Table 11 reveals that average student scale scores for the Texas grade 8 NAEP mathematics test ranged from 270 to 285 across the years-of-teaching experience categories. The mean scale score of students of teachers with 11-24 years-of-teaching experience (280) was statistically significantly ($p < .01$) higher than the mean scale score of students of teachers with 2 years or less years of experience (270) with an effect size of .22. The mean scale score of students with teachers who had 11-24 years-of-teaching experience (280) was also higher than

the mean scale score of students of teacher with 3-5 years-of-teaching experience (271) with an effect size of .14, and the mean scale score of students of teachers with 6-10 years-of-teaching experience (273) with an effect size of .13.

Table 11. 2000 NAEP Texas Mathematics Grade 8 Scores by Years-of-Teaching Experience.

OVERALL PERFORMANCE															
	2 years or less			3-5 years			6-10 years			11-24 years			25 years or more		
N	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.	Avg. Score	S.E.	Row Pct.
2237	270	4.6	20%	271	3.2	18%	273	2.1	21%	280	2.4	31%	285	3.4	9%

In addition, the mean scale score of students' of teachers with 25 years or more experience teaching mathematics (285) were statistically significantly ($p < .01$) higher than the mean scale scores of students of teachers with 2 or fewer years of teaching experience (270) with an effect size of .37, and students of teachers with 3-5 years-of-teaching experience (271) with an effect size of .35.

The mean scale score of students of teachers' with 25 years or more experience teaching mathematics (285) was also statistically significantly ($p < .01$) higher than the mean scale scores of students of teachers with 6-10 years of experience (273) with an effect size of .39. Forty percent of Texas teachers in the NAEP sample have 11 or more years of experience.

Discussion

This study has not found convincing evidence that there are meaningful differences among student mean scale scores on the 2000 NAEP Mathematics Test by teachers' years of experience teaching mathematics. Even when there was statistical significance ($p < .01$) between students' NAEP mathematics scores by their teachers' years of experience, the effect sizes of

these differences could only be interpreted as "very small"—less than .2 standard deviation—or "small"—greater than .2 but less than .5 standard deviation. Generally speaking, the smaller effect sizes for significant differences were found in the national and national public samples of student test results. Using these sample categories yielded effect size estimates that ranged as low as .08. The largest effect sizes, which were found in the eighth grade test results from Kentucky and Texas, were in the .34 to .39 range.

Despite some evidence for significant differences in mathematical performance, no causal inferences can be drawn from this study as it was limited to a secondary correlational analysis. The lack of strong, or even moderate, differences associated with teachers' years of experience could be the result of little variation in the data as a whole. Nevertheless, the lack of variation in students' mean scaled scores across the years of mathematical teaching experience of their teachers is remarkable, especially at the state level. With on-going school reform efforts strengthening the standards for teacher preparation, perhaps the *absence* of lower student scores for students of the newest teachers (2 years or less) (Darling-Hammond, 2000) offers some evidence that these reforms may be working.

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